EO/US
PCT/GB00/00940

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing: 14 December 2000 (14.12.00)	
International application No.: PCT/GB00/00940	Applicant's or agent's file reference: C.ILAS 2-6-6
International filing date: 14 March 2000 (14.03.00)	Priority date: 09 June 1999 (09.06.99)
Applicant: ILAS, Constantin et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International preliminary Examining Authority on:

25 September 2000 (25.09.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer: J. Zahra
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

Form PCT/IB/331 (July 1992)

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Europäisches Patentamt
Zweigstelle in Den Haag Recherchen-abteilung

Europea[redacted] Patent O[redacted]
Branch at The Hague Search division

Office européen des brevets
Département à La Haye Division de la recherche

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Datum/Date
10.02.00

Zeichen/Ref./Réf.	Anmeldung Nr./Application No./Demande n°./Patent Nr./Patent No./Brevet n°.
C.ILAS 2-6-6	99304507.9-2211-

Anmelder/Applicant/Demandeur/Patentinhaber/Proprietor/Titulaire
LUCENT TECHNOLOGIES INC.

COMMUNICATION

The European Patent Office herewith transmits as an enclosure the European search report for the above-mentioned European patent application.

If applicable, copies of the documents cited in the European search report are attached.

☐ Additional set(s) of copies of the documents cited in the European search report is (are) enclosed as well.

The following specifications given by the applicant have been approved by the Search Division:

☒ abstract ☒ title

☐ The abstract was modified by the Search Division and the definitive text is attached to this communication.

The following figure will be published together with the abstract: 16

6/99

EUROPÄISCHES PATENTAMT - EUROPEAN PATENT OFFICE - OFFICE EUROPÉEN DES BREVETS - DEN HAAG - THE HAGUE - LA HAYE

REFUND OF THE SEARCH FEE

If applicable under Article 10 Rules relating to fees, a separate communication from the Receiving Section on the refund of the search fee will be sent later.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 30 4507

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	ERIKSSON S ET AL: "Comparison of link quality control strategies for packet data services in EDGE" 1999 IEEE 49TH VEHICULAR TECHNOLOGY CONFERENCE (CAT. NO.99CH36363), 1999 IEEE 49TH VEHICULAR TECHNOLOGY CONFERENCE. MOVING INTO A NEW MILLENIUM, HOUSTON, TX, USA, 16-20 MAY 1999, pages 938-942 vol.2, XP002127832 1999, Piscataway, NJ, USA, IEEE, USA ISBN: 0-7803-5565-2 * page 938 - page 940 * ---	1-12	
A	WO 99 14963 A (NOKIA TELECOMMUNICATIONS OY ;HUTTUNEN KARI (FI); SAVUOJA ARTO (FI)) 25 March 1999 (1999-03-25) * abstract * * page 1, line 1 - line 27 * * page 9, line 14 - page 10, line 28; claim 1; figures 4,5 * ---	1-3,7	
A	WO 99 16264 A (ERICSSON TELEFON AB L M) 1 April 1999 (1999-04-01) * abstract * * page 2, line 26 - page 3, line 2 * * page 6, line 12 - page 8, line 7; claim 1; figures 3-6 * ---	1-3,7	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	NOBELEN VAN R ET AL: "AN ADAPTIVE RADIO LINK PROTOCOL WITH ENHANCED DATA RATES FOR GSM EVOLUTION" IEEE PERSONAL COMMUNICATIONS,US,IEEE COMMUNICATIONS SOCIETY, vol. 6, no. 1, page 54-64 XP000804156 ISSN: 1070-9916 * page 55, left-hand column, last paragraph - page 59, left-hand column * * page 64 * -----	1-12	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	17 January 2000	Staeger, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 30 4507

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	PIRHONEN R ET AL: "TDMA based packet data system standard and deployment" 1999 IEEE 49TH VEHICULAR TECHNOLOGY CONFERENCE (CAT. NO.99CH36363), 1999 IEEE 49TH VEHICULAR TECHNOLOGY CONFERENCE. MOVING INTO A NEW MILLENIUM, HOUSTON, TX, USA, 16-20 MAY 1999, pages 743-747 vol.1, XP002127830 1999, Piscataway, NJ, USA, IEEE, USA ISBN: 0-7803-5565-2 * abstract * * page 743 - page 745 * ---	1-12	H04B7/26 H04L12/64 H04J3/16
A	SCHRAMM P ET AL: "Radio interface performance of EDGE, a proposal for enhanced data rates in existing digital cellular systems" VTC '98. 48TH IEEE VEHICULAR TECHNOLOGY CONFERENCE. PATHWAY TO A GLOBAL WIRELESS REVOLUTION (CAT. NO.98CH36151), VTC '98. 48TH IEEE VEHICULAR TECHNOLOGY CONFERENCE. PATHWAY TO A GLOBAL WIRELESS REVOLUTION, OTTAWA, ONT., CANADA, 18-21 MAY 1998, pages 1064-1068 vol.2, XP002127831 1998, New York, NY, USA, IEEE, USA ISBN: 0-7803-4320-4 * abstract * * page 1064 - page 1066 * --- -/--	1-12	TECHNICAL FIELDS SEARCHED (Int.Cl.7) H04B H04L H04J H04Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	17 January 2000	Staeger, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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T : theory or principle underlying the invention
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D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 30 4507

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-01-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9914963 A	25-03-1999	FI 973681 A	13-03-1999
		AU 9164798 A	05-04-1999
WO 9916264 A	01-04-1999	AU 9286498 A	12-04-1999

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PATENT COOPERATION TREATY

REC'D 19 JUL 2001
WIPO PCT

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
C.ILAS 2-6-6		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/00940	14/03/2000	09/06/1999
International Patent Classification (IPC) or national classification and IPC H04B7/26		
Applicant LUCENT TECHNOLOGIES INC. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 16 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
25/09/2000	17.07.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Staeger, R Telephone No. +49 89 2399 8124

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/00940

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

4,7,9-12,14-21,23-26, 28,31-36,38-44	as published			
2,3	as received on	09/03/2001	with letter of	09/03/2001
1,1a,2a,5,6,8,13, 22,27,29,30,37	as received on	29/06/2001	with letter of	25/06/2001

Claims, No.:

1-11	as received on	29/06/2001	with letter of	25/06/2001

Drawings, sheets:

1/23-23/23	as published

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence

listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:
   ☐ the claims, Nos.:
   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-11
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-11
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-11
	No:	Claims	

2. Citations and explanations
   see separate sheet

V. Reasoned statement with regard to novelty and inventive step:

0. The present invention relates to a TDMA packet switched network, and particularly but not exclusively to an EDGE (enhanced data rates for GSM) system for the transmission of speech data.

1. The closest prior art, which was not available for this report, is cited in the description (page 1, line 22 to p. 2, l. 10; p. 5, last paragraph to p. 6, first paragraph; **p. 27, l. 4 to p. 29, l. 7, figures 15a to 15d**) discloses a TDMA packet switched network of an EDGE system in which for data transmission (not speech data) a transmission structure of RLC/MAC blocks is proposed, where each RLC/MAC block (e.g. 1392 bits) to be transmitted is interleaved over four successive time frames and hence over four time slots (fig. 15d).

2. **Problem:**
To provide an efficient method or transmission structure for interleaving voice data from different users in the time slots of a TDMA frame, which is suitable for the transmission in an EDGE system.

3. **Solution:**
The following feature renders the method of claim 1 inventive:
encoding speech data of at last two users into a single RLC/MAC block, allocating at least one time slot of a TDMA frame to the RLC/MAC block and transmitting said block in the allocated time slots(s) such that **at least one of the allocated time slots carries speech data from each of the at least two users.**

4. None of the documents of the Search Report gives an indication to such an encoding, allocating and transmitting of speech data.

5. Claims 1-11 are based on claims 1-12 as published.

MULTI-USER TIME SLOTS FOR TDMA

Field of the Invention

The present invention relates to TDMA systems, and particularly but not exclusively to an EDGE system for the transmission of voice generated by a GSM speech encoder.

Background to the Invention

Time division multiple access (TDMA) systems, such as GSM, have a plurality of time slots in a given time frame. For example in GSM each TDMA time frame has eight time slots. Conventionally, each time slot is reserved for use by a particular user.

Digital mobile communication systems for voice such as GSM (Global System for Mobile Communication), and DAMPS (Digital Advanced Mobile Systems) have expanded very rapidly in recent years.

In addition great demand for data service has been created by mobile users due to wide spread acceptance of the Internet. GPRS (General Packet Radio Service), EDGE (enhanced data rate for GSM), and UMTS (Universal Mobile Telecommunications Services) are all being developed to accommodate data users in wireless networks.

Schemes for the transmission of voice over fixed packet switch networks have also been developed in recent years and an increasing amount of voice traffic will be carried over packet switched networks in the future.

The enhanced data rate for GSM evolution (EDGE) is a proposal for the evolution of existing time division multiple access (TDMA) radio cellular systems in order to support higher transmission data rates and increase the capacity of these networks. The application of EDGE is restricted not only to GSM cellular networks but also has been accepted for the evolution of IS-136 systems by UWCC (Universal Wireless Communications Consortium). Enhanced data rates are achieved by introducing higher level modulation formats, such as 8-PSK (phase shift keying). With the

introduction of such modulation schemes, EDGE systems can offer bit rates of up to approximately three times higher than standard GSM/GPRS/IS-136 systems.

EDGE was initially developed in order to provide data service at higher rates than GSM or GPRS, by making use of multi-phase modulation (such as 8-PSK) instead of binary GMSK. However, the structure of the proposed RLC/MAC blocks for data transmission do not allow for the efficient use of the available radio resources for voice transmission. Furthermore, due to the use of 8-PSK more powerful channel coding is required in order to maintain certain levels of voice quality .

It is an object of the present invention to provide an efficient transmission scheme for interleaving data from different users in the time slots of a TDMA frame, which is particularly suited to the transmission of voice in an EDGE network.

Summary of the Invention

According to the present invention there is provided a method of transmitting speech frames in a TDMA packet switched network in which at least one time-slot of the TDMA frame is allocated to at least two users, the method comprising: encoding user data from the at least two users into a single RLC/MAC block; allocating a time slot to the RLC/MAC block; and transmitting the encoded RLC/MAC block in the time-slot.

The encoded RLC/MAC block may be transmitted in a plurality of said time-slots.

The network may be a wireless network and the speech frames may be transmitted on the down-link of the network, wherein the transmitting step includes a step of interleaving the RLC/MAC block such that at least one time-slot carries user data from each of the two users simultaneously. Preferably the at least one time-slot carries part of the user data from each of the two users simultaneously. The network may be an EDGE packet switched network and the user data may be speech, the RLC/MAC

blocks being transmitted in four time-slots. User data from two users may be encoded, each time slot carrying a quarter of the encoded user data for each user.

The network may be a wireless network and user data is transmitted on the up-link of the network and wherein the transmitting step includes a step of interleaving the RLC/MAC block such that at least one time slot carries user data from only one of the two users in each TDMA frame. The at least one time-slot may carry part of the user data from one of the two users in each TDMA frame. An encoded speech frame from each of the two users may be carried over an alternate plurality of the at least one time slots. The network may be an EDGE packet switched network and the user data is speech, the RLC/MAC blocks being transmitted in four time-slots. User data from two users may be encoded, alternate time slots carrying half of the encoded user data for each user.

The invention will now be described by way of example with reference to the accompanying drawings, in which:

Brief Description of the Figures

Figures 1(a) and (b) illustrate a first example of a header structure for transmitting voice over an EDGE network;

Figures 2(a) and (b) illustrate a second example of a header structure for transmitting voice over an EDGE network;

Figures 3(a) and (b) illustrate a third example of a header structure for transmitting voice over an EDGE network;

Figures 4(a) and (b) illustrates system performance improvements using the header of Figure 3;

Figure 5 illustrates an encoder for generating the header of Figure 3(a);

Figure 6 illustrates a decoder for decoding the header of Figure 3(a);

Figure 18 illustrates circuitry for generating an RLC/MAC block in the down-link of an EDGE system;

Figures 19(a) to 19(c) illustrate one embodiment of the generation of an RLC/MAC block from two speech frames from the same users in the down-link of an EDGE network utilising the circuit of Figure 18;

Figures 20(a) to 20(c) illustrate an embodiment, corresponding to the embodiment of Figure 19, for generating an RLC/MAC block in the up-link of an EDGE system;

Figure 21 illustrates a convnetional GSM/GPRS burst structure;

Figure 22 illustrates one embodiment of a preferable burst structure;

Figures 23(a) to 23(c) illustrate an embodiment, corresponding to the embodiment of Figure 19, for generating an RLC/MAC block in the up-link of an EDGE system;

Figure 24 illustrates another embodiment of a preferable burst structure; and

Figure 25 illustrates an example implementation of the preferable burst structures of Figures 22 and 24.

Description of Preferred Embodiments

The enhanced data rate for GSM evolution (EDGE) has been developed to support the transmission of data packets in wireless networks. Networks supporting the transmission of data packets are conventionally known as packet switched networks. In packet switched networks such as EDGE, the data is transmitted in data packets which include a header and a payload. Each data packet is encoded into a Radio Link Control/Medium Access Control (RLC/MAC) block. The payload includes the information portion of the data packet. The header includes control and routing information associated with the data packet. For example, the header usually includes the destination address of the data packet, error checking information, and control bits for enabling receipt of the packet to be

acknowledged, and if necessary to request retransmission of the packet. One characteristic of data packet transmission is that if the receiver in the network does not successfully receive the transmitted packet, then retransmission of the data packet is requested.

In sending voice, as opposed to data, the requirements for transmission are different. For example, in voice transmission it is impractical for information to be re-transmitted because of time delay constraints. Therefore voice transmission in packet switched networks is unacknowledged voice packet transmission. In addition, with voice different bits of the encoded speech have different importance, and it is acceptable for certain bits to be lost. However in data every bit is assumed to have equal importance, and no bits should therefore be lost.

It is herein proposed to transmit voice over an EDGE packet switched network. In order to do this, a new RLC/MAC block structure is proposed in which the conventional EDGE header is modified to include those fields required to support only voice transmission. Referring to Figure 1, there is shown a first embodiment of a new RLC/MAC block header, suitable for transmission of voice over EDGE. The new RLC/MAC block structure includes a header which is reduced compared to the header of the data packets for EDGE. That is, the length of the header is shorter than that which is required for the transmission of data packets.

Thus to send voice over an EDGE network, it is proposed to change the RLC/MAC block of a standard data packet. The new block contains a header, and a payload consisting of the coded speech bits coded using a standard GSM speech encoder.

This new RLC/MAC block is coded in a different way from that of a known standard EDGE packet. This change of coding is required because for speech data different bits have different importance whereas for data every bit has equal importance.

The TFI field uniquely identifies a data flow. When a call is established, it is assigned a unique number. When a mobile station or a base station receives a packet and reads its header it knows which data flow (call) this packet belongs to, by reading the TFI field.

When the SF field is set to 1, the speech frame corresponds to speech. If the SF field is set to 0, the speech frame corresponds to silence.

When the FBI field is set to 1, this is an indication to the receiver that the current data flow is ended. If the FBI field is set to 0, this means that there are more packets to be transmitted in the current data flow.

Figure 2 shows a second embodiment of the new header for transmission of voice over EDGE. Figure 2(a) shows the header for transmission of voice in the up-link of an EDGE network further modified to include a set of error checking bits in a cyclic redundancy checking (CRC) field 18. The new header 20 still includes the USF field 4, the TFI field 6, and the FBI field 8.

Figure 2(b) shows the header for transmission of voice in the down-link of an EDGE network also further modified to include a set of error checking bits in a cyclic redundancy checking (CRC) field 22. The new header 24 still includes the TFI field 12, the SF field 14, and the FBI field 16. The provision of the error checking bits provides extra protection for the header. Although the headers of Figures 2(a) and 2(b) are described with reference to a CRC field for error checking, it will be appreciated that any other error checking scheme suitable for detection of errors may be utilised in accordance with the application.

The size of the CRC field in both the up-link and the down-link headers is dependent upon the error code used in the system. In a simple error checking scheme, the CRC field is generated in dependence upon the other fields in the header. At the receiver, the error field is compared to a re-calculation of the CRC field based on the received header, and if an error is detected then the speech block is discarded. In data transmission this is

the header decoding circuitry includes an input circuit 62, a cyclic code generator circuit 64, and an error correction and detection block 66. The input circuit receives the 16 bits of the decoded header, having the format of Figure 3(a), on line 70. The five bits of the cyclic code are provided on line 84 to the error correction and detection block. The 12 bits of the header on which the cyclic code is based are provided on line 82 to the cyclic code generator circuit, which applies the same cyclic code applied in the cyclic code generator circuit 58 of the transmitter. The thus generated additional cyclic code is presented on line 86 to the error correction and detection circuit 66. Thus the error correction and detection circuit 66 detects the presence of an error and attempts to correct it as discussed hereinabove. Again, from the description hereinabove it can be readily understood how the circuit of Figure 6 can be modified for the up-link.

In the following discussion, specific examples of encoding speech frames for transmission over EDGE are given. In these example one or another of the improved headers discussed hereinabove is utilised. It will be apparent, however, that alternative headers may be used whilst still gaining from the advantages of the described encoding techniques.

In transmitting voice over EDGE, it is advantageous wherever possible to use the components of a standard speech encoder for generating the speech frames for transmission. In the following examples, standard GSM speech encoders are utilised. However, other speech encoders may be utilised. In GSM, speech frames have Class I bits and Class II bits, and the Class I bits are further split into a Class Ia category and a Class Ib category. In general in speech different bits have different importance, and therefore in a more general case the important bits (Class I in GSM) can be considered as primary bits, and the less important bits (Class II in GSM) can be considered as secondary bits.

Two Speech Frames from same User

In the following description, two examples are given of the encoding of two speech frames which are associated with different users. One characteristic of speech frames from different users is that in the down-link one user does not have any information about the other user.

The principle described hereinabove for encoding four speech frames from the same user in a single RLC/MAC block may be further extended to the encoding of larger numbers of speech frames from the same user in a single RLC/MAC block.

Two Speech frames from Different User - Case 1

Referring to Figure 12, there is shown a block diagram illustrating one embodiment for encoding two speech frames from two different users in the down-link of a packet switched network. The down-link encoder of Figure 12 corresponds substantially to the down-link encoder of Figure 7, and like reference numerals have been used to denote like elements. The main difference lies in the addition of a further block code circuit 141. In addition the convolution encoder circuits 126 and 128 are modified to additionally include puncturing, as will be described further hereinbelow.

This embodiment utilises the 244 bit speech frames generated by an enhanced full-rate GSM speech encoder, as described hereinabove with reference to Figure 7. The 244 bits of a first speech frame U1SF1 from a first user are received on the signal line 100, and the 244 bits of a first speech frame U2SF1 from a second user are received on the signal line 102. Each of the 244 bit speech frames U1SF1 and U2SF1 are processed by the preliminary coding circuits 104 and 106, the block code circuits 112 and 118, and the reordering circuits 120 exactly as described hereinabove with reference to Figure 7.

As the two speech frames are from different users, then there are two respective different headers associated with each speech frame. Hence the block code circuit 141 is introduced to handle the header associated with the second user speech frame on line 102. The header associated with the

a series of TDMA frames, each of which is split into a number of time slots. Each time slot, in a circuit switched network having dedicated physical channels, is allocated to, and reserved for sole use by, one particular user. Each user then transmits in their time-slot of each TDMA frame, both in the down-link and the up-link.

Referring to Figure 15(b), there is shown the standard format of a GSM/GPRS burst. The burst 600 comprises a set of 3 tail bits 606 at the front, followed by a set of 58 data bits 608, followed by a set of 26 bits 610 comprising a training sequence, followed by a set of 58 data bits 612, followed by a further 3 tail bits 614 and finally a set of 8.25 bits comprising a guard 616.

Information is transmitted on the physical channel in TDMA time slots, as illustrated in Figure 15(a). In a TDMA system each TDMA time frame 611 comprises a set of time slots, and in the example of Figure 15(a) each time frame comprises a set of eight time slots TN1 to TN8. Each time slot TN1 to TN8 of a TDMA frame carries a burst having the format shown in Figure 15(b). Ordinarily, each time slot within a frame is reserved for use by a particular user.

Referring to Figure 15(c), the interleaving of a data RLC/MAC block into TDMA frames in a conventional GSM/GPRS system is shown. Block 800 represents the 464 bits of a first RLC/MAC speech block associated with a first user, block 802 represents the 464 bits of a second RLC/MAC block associated with the same first user, and block 804 represents the 464 bits of a third RLC/MAC speech block associated with the same user.

In conventional GSM/GPRS, the 464 bits of a particular block, e.g. the second block 802, are interleaved over eight bursts (in eight TDMA frames) with the least half of the bits from the previous block 800 (designated by reference numeral 801) and the first half of the bits from the next block 804 (designated by reference numeral 805).

As can be seen from Figure 15(d), each burst can carry 348 bits of data, and therefore the 1392 bits of data of the encoded RLC/MAC block can be transmitted over four bursts. However, in the embodiments described herein for the transmission of voice over EDGE the 1392 bits of data may be from two different users, and ordinarily each user would need to be allocated a separate time slot in each time frame.

In order to facilitate a particularly advantageous transmission scheme, there is proposed herein a scheme in which two users share a time slot within a TDMA frame on both the down-link and the up-link. This scheme may be applied advantageously to the transmission of speech frames from two different users over EDGE encoded according to the technique described hereinabove.

According to the new technique proposed herein, the data from each of the two users is transmitted in a common time frame. Referring to Figure 13(c) it can be seen that the encoded RLC/MAC block comprises 696 bits associated with the first user (including four stealing bits), and 696 bits associated with the second user (including four stealing bits). In accordance with the new technique, in the down-link a quarter of the encoded bits associated with the first user are transmitted in an allocated time slot of each frame on four successive frames, and a quarter of the encoded bits associated with the second user are transmitted in the same allocated time slot of each time frame on the same four successive frames.

Thus, suppose that time slot TN3 is allocated to the two users. In time slot TN3 of time frame TF1 174 bits (including one stealing bit) of the encoded RLC/MAC associated with the first user are transmitted in the data portion 608 of the burst, and 174 bits (including one stealing bit) of the encoded RLC/MAC associated with the second user are transmitted in the data portion 612 of the burst. In time slot TN3 of time frame TF2 a further 174 bits (including one stealing bit) of the encoded RLC/MAC associated with the first user are transmitted in the data portion 608 of

the burst, and a further 174 bits (including one stealing bit) of the encoded RLC/MAC associated with the second user are transmitted in the data portion 612 of the burst. This is then repeated for a further two bursts such that all 1392 bits of the burst are transmitted in four successive bursts.

Referring to Figure 16, there is further illustrated the principle of such a scheme applied to the down-link, for transmitting the RLC/MAC blocks of Figure 13(c).

A block designated by reference numeral 400 represents 160 samples of speech associated with a first user in a 20ms time frame, prior to initial channel encoding. As represented by the arrow 404, these 160 samples are encoded into a 260 bit speech frame for the first user as designated by reference numeral 408, which are the set of bits on the output 108 of the preliminary coding circuit 104. These 260 bits still occupy a 20ms time period. The 260 bits of the speech frame are then encoded into the 696 bits constituting half of the RLC/MAC block on the output 149 of the output circuit 116, which step is represented by arrow 412. The 696 bits of the RLC/MAC block are designated by reference numeral 416.

Similarly, for the second user, the arrows 406, 410 and 414 correspond directly to the functions illustrated by the arrows 400, 408 and 416 respectively. The blocks designated 402, 410, and 414 for the second user correspond directly to the blocks 404, 412 and 416 for the first user.

Thus the block 418 corresponds to the set of 696 bits of the RLC/MAC block of Figure 13(c) associated with the second user.

The third time slot of the TDMA frames is allocated to both users. In a first frame TF1 a first quarter of the encoded data for each user plus two respective steering bits is transmitted. In a second frame TF2 a second quarter of the encoded data for each user plus two respective stealing bits is transmitted. In a third frame TF3 a third quarter of the encoded data for each user plus two respective stealing bits is transmitted. In a fourth

Finally, the RLC/MAC block 324 for transmission is illustrated in Figure 20(c), and includes all the bits of Figure 20(b) designated by reference numeral 336 together with the 4 stealing bits designated by reference numeral 328.

The speech frame of the second user is similarly encoded, and results in an RLC/MAC block with the identical format to that of Figure 20(c).

New Burst Structure

Figure 21 illustrates the conventional structure of a normal burst, and is identical to that shown and described previously with reference to Figure 15(b). However, in Figure 21 the number of bits in each portion of the burst corresponds to those which can be accommodated using 8 PSK modulation.

In the following a new burst structure based on the GSM/GPRS burst structure is proposed, which advantageously utilises the encoding technique for the up-link described with reference to Figure 20. Referring to Figure 22 there is shown a new burst structure 602, equivalent in length to the burst structure of Figure 21, but having tail portions 618, 626, 630 and 638, data portions 620, 624, 632, and 636, training sequences 622 and 634, and guard portions 628 and 640. The 456 bits of an encoded RLC/MAC block are interleaved over four half bursts and passed to the 8 PSK modulator.

Figure 23 shows a second example of up-link coding. In Figure 23(a) there is shown the unencoded speech block 320 of Figure 20(a).

The encoded speech block 340 is illustrated in Figure 23(b). In this example, the up-link header and the set of Class I bits are encoded together by a 3,1,7 convolution code, with puncturing of 181 bits.

This scheme uses (3,1,7) convolutional code rather than (2,1,7) convolutional code in previous section. This code has better coding gain but it produces more bits and lot puncturing has to be done.

Claims

1. A method of transmitting speech frames in a TDMA packet switched network in which at least one time-slot of the TDMA frame is allocated to at least two users, the method comprising: encoding user data from the at least two users into a single RLC/MAC block; allocating a time slot to the RLC/MAC block; and transmitting the encoded RLC/MAC block in the time-slot.

2. The method of claim 1 in which the encoded RLC/MAC block is transmitted in a plurality of said time-slots.

3. The method of claim 1 or claim 2 in which the network is a wireless network and the speech frames are transmitted on the down-link of the network, wherein the transmitting step includes a step of interleaving the RLC/MAC block such that at least one time-slot carries user data from each of the two users simultaneously.

4. The method of claim 3 in which the at least one time-slot carries part of the user data from each of the two users simultaneously.

5. The method of any one of claims 3 to 4 in which the network is an EDGE packet switched network and the user data is speech, the RLC/MAC blocks being transmitted in four time-slots.

6. The method of claim 5 wherein user data from two users is encoded, each time slot carrying a quarter of the encoded user data for each user.

7. The method of claim 1 or claim 2 in which the network is a wireless network and user data is transmitted on the up-link of the network and wherein the transmitting step includes a step of interleaving the RLC/MAC block such that at least one time slot carries user data from only one of the two users in each TDMA frame.

8. The method of claim 7 in which the at least one time-slot carries part of the user data from one of the two users in each TDMA frame.

9. The method of claim 8 in which an encoded speech frame from each of the two users is carried over an alternate plurality of the at least one time slots.

10. The method of any one of claims 7 to 9 in which the network is an EDGE packet switched network and the user data is speech, the RLC/MAC blocks being transmitted in four time-slots.

11. The method of claim 5 wherein user data from two users is encoded, alternate time slots carrying half of the encoded user data for each user.

12. The method of any one of claims 1 to 11 wherein the user data comprises speech.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
C.ILAS 2-6-6		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/ 00940	14/03/2000	09/06/1999
Applicant		
LUCENT TECHNOLOGIES INC. et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 16

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
PC[redacted]B 00/00940

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B7/26 H04L12/64 H04J3/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B H04L H04J H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PIRHONEN R ET AL: "TDMA based packet data system standard and deployment" 1999 IEEE 49TH VEHICULAR TECHNOLOGY CONFERENCE (CAT. NO.99CH36363), 1999 IEEE 49TH VEHICULAR TECHNOLOGY CONFERENCE. MOVING INTO A NEW MILLENIUM, HOUSTON, TX, USA, 16-20 MAY 1999, pages 743-747 vol.1, XP002127830 1999, Piscataway, NJ, USA, IEEE, USA ISBN: 0-7803-5565-2 abstract page 743 -page 745 --- -/--	1-12

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 May 2000	18/05/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Staeger, R

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Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 00/00940

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WO 9914963 A	25-03-1999	FI 973681 A	13-03-1999
		AU 9164798 A	05-04-1999
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